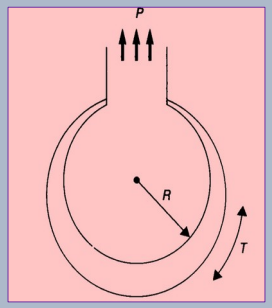
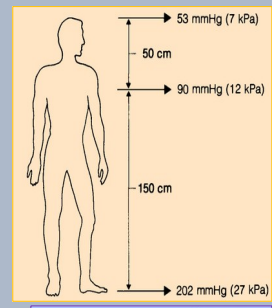
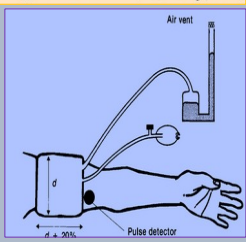
Blood Pressure



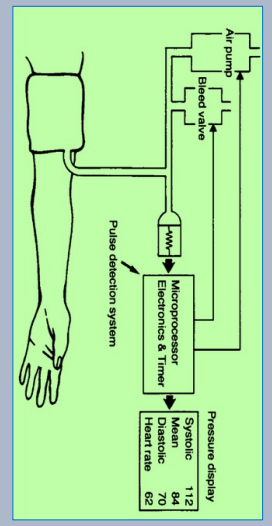
PRESSURE AT THE HEART: **The simple concept of pressure as force per unit area is less clear >>contraction of the muscle is acting tangentially at the heart surface>> tension (force per unit length and pressure *P* resulting from T tension of the ventricular wall >>Laplace's law for a sphere>>** **P=2T/R.** Distended failing heart has a larger radius >> pressure produced falls unless the muscle contracts proportionately more forcefully. In the normal heart >> increased venous return >> lengthening of cardiac muscle increases the force of contraction (Starling's law of the heart) and the pressure is maintained. The mechanical work >> product of the pressure, and the stroke volume .Consequently, an increase of blood pressure or of



PRESSURE IN THE CIRCULATION: In a tall man who is standing, the mean blood pressure could vary from 53 mmHg (7 kPa) at his head to 202 mmHg (27 kPa) at his feet, compared with a mean pressure of 90 mmHg (12 kPa) at Because there is a fall in pressure as a fluid flows through a tube>> mean pressure in arterioles would be lower than in arteries, but >> blood pressure is pulsatile
, blood pressure also shows a diurnal variation (lower during sleep) , changes of pressure occur too during the respiratory cycle and more marked changes occur during
intermittent positive pressure ventilation >>due to the effect on venous return. Anxiety raises the blood pressure, so readings>>on three separate occasions.
The total flow in the circulation with tl: The simplest: (1-The cuff must be positioned so that the centre of its bladder is on the medial side of Cardiac output >> a patient with a nthe arm . The width of theistance (e.g. with a warm, pink skin) a high blood pressure indicates that a high cardiac output is likely.
Mean pressure =diastolic pressure plus one-third of pulse pressure



MEASUREMENT OF BLOOD PRESSURE
cuff should be 20% greater than the diameter of the arm *d.* 2-The mercury type of manometer must read zero >> before use, and it should be used vertically. Partial blockage of the air vent or of the connecting tubings >> inaccurate or sluggish readings. Although aneroid gauges are more portable, >> calibration should be checked regularly.
The cuff is inflated to a pressure above the expected systolic pressure, and this is then slowly released at a rate of 2 to 3 mmHg per second. The systolic pressure >>reappearance of the peripheral pulse, 3-By a detector, a- Simplest form >> manual palpation of the radial pulse. b-Auscultation over the brachial artery>> the first-phase Korotkoff sound.
The second phase is a slight muffling and the third a rise in volume (sounds from blood flow in the artery first appear of the auscultation sounds). The fourth phase >>an abrupt fall in sound level and is sometimes >> diastolic pressure, although the final loss of all sound (fifth phase of Korotkoff) is >> accepted as indicating diastolic pressure. d-A microphone with electronic circuitry is sometimes used in place of a stethoscope>> paramedical staff. In anaesthesia, a pulse detector or e-pulse oximeter detector is often used. Other more specialized detector systems are available a (the oscillometric system, or an ultrasonic detector) .



OSCILLOMETRY: As the cuff is deflated from above systolic pressure the needle on an aneroid gauge will start to oscillate when systolic pressure is reached ,and the oscillations of the needle increase in amplitude to a maximum at the mean blood pressure then decrease at a less precise point about the diastolic pressure>>The Von Recklinghausen Oscillotonometer (uses a double cuff).
AUTOMATED OSCILLOMETRIC TECHNIQUE: Unlike the old oscillotonometer a single cuff is normally used and instead of the bellows a pressure transducer measures both the pressure and the oscillations. The processing unit analyses the signal from the transducer

OTHER AUTOMATED TECHNIQUES: 1- A microphone may be positioned over the brachial artery >>audible sound or infrasound. 2- Incorporating an ultrasonic trans**mitter and receiver which are positioned, with appropriate gel for good contact, to detect the Doppler changes of frequency from the arterial wall movement>>difficult to position the detectors correctly over the artery in contrast to THE PENAZ c techniques which are less dependent on positioning.**

TECHNIQUE:

The system also includes at the cuff an infrared light emitting diode and a photocell which >>photoplethysmograph. The photocell measures absorption at an infrared wavelength appropriate for arterial blood and so detects the volume of arterial blood in the finger under the cuff. The volume varies according to the degree of distension of the arteries during systole. An electronic processor analyses the photoplethysmograph to determine the volume at a point set according t**INVASIVE TECHNIQUES:**re. Then the servocontrol valve at the air pump acts as a feed back mechanism, continuously inflating or deflating the finger cuff in order to maintain the photoplethysmograph output constant at this set point. Some perfusion of the finger continues despite the continuous inflation of the finger cuff .

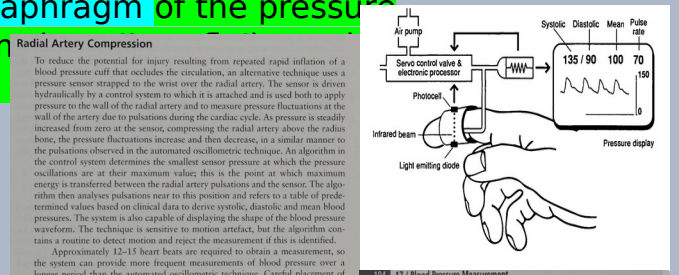
Artery >> infusion system, transducer and recorder. Modified Allen test >> hand is clenched into a fist ,occludes both the radial and ulnar arteries by fingers, then the patient relaxes his clenched fist and releases the pressure on the ulnar artery. The patient's hand should then flush within 5 seconds. If delayed>>poor blood vessel collaterals between the radial and ulnar arteries >>another artery should be used. If the ulnar artery is used the pressure is released over the radial artery first. A local anaesth. >>conscious patient, as open exposure rarely being necessary. It rarely cause thrombosis >>Teflon canula, short with parallel sides and sutured .To prevent clotting >>intermittent flushing with heparinized saline through a three-way tap may be satisfactory. A high pressures generated by small syringes >> damage arterial walls or the diaphragm of the pressure

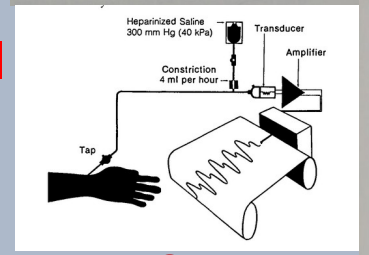
THE ARTERIAL PRESSURE RECORDING: ot be used. For longer term recording a continuous flushing systen

The final waveform produced may be displayed on an oscilloscope or a recorder tracing. The blood pressure wave he becomes narrower and increases in amplitude in peripheral arteries so that, even with the patient supine, the systolic pressure in the dorsalis pedis artery is higher than in the radial and higher than that in the aorta>>1- change in diameter of the vessels and their 2-elasticity, and the 3- reflection of the wave pattern from the vessel walls. **The systolic and diastolic pressures are easily identified on a tracing and the systolic pressure is found to be an average of 5 mmHg higher with direct measurement at the radial artery than with indirect techniques, while the diastolic pressure is about 8 mmHg lower. The dicrotic notch >>intra-aortic vibrations. In the case of the arterial pressure wave, the frequency range is 0 Hz to about 40 Hz. The apparatus used for arterial pressure measurement must be able to respond adequately to this range of frequencies. Usually, the amplifiers and recorders have no difficulty in dealing with this frequency range, but problems may arise in relation to the transducer itself and its connections to the cannula.**

RESONANCE AND DAMPING:

Movement of the diaphragm of the pressure transducer converts the blood pressure change into an electrical signal. This movement of the diaphragm is associated with a very small movement of saline to and fro along the catheter with changes of pressure. Just as a weight on the end of a spring will oscillate at a particular frequency (known as the resonant frequency), so the pressure measuring system consisting of the transducer ,diaphragm, catheter and saline column possesses a resonant


Radial Artery Compression
To reduce the potential for injury resulting from repeated rapid inflation of a blood pressure cuff that occludes the circulation, an alternative technique uses a pressure sensor strapped to the wrist over the radial artery. The sensor is driven hydraulically by a control system to which it is attached and is used both to apply pressure to the wall of the radial artery and to measure pressure fluctuations at the wall of the artery due to pulsations during the cardiac cycle. As pressure is steadily increased from zero at the sensor, compressing the radial artery above the radius bone, the pressure fluctuations increase and then decrease, in a similar manner to the pulsations observed in the automated oscillometric technique. An algorithm in the control system determines the smallest sensor pressure at which the pressure oscillations are at their maximum value; this is the point at which maximum energy is transferred between the radial artery pulsations and the sensor. The algorithm then analyses pulsations near to this position and refers to a table of predetermined values based on clinical data to derive systolic, diastolic and mean blood pressures. The system is also capable of displaying the shape of the blood pressure waveform. The technique is sensitive to motion artefact, but the algorithm contains a routine to detect motion and reject the measurement if this is identified.
Approximately 12–15 heart beats are required to obtain a measurement, so the system can provide more frequent measurements of blood pressure over a longer period than the automated oscillometric technique. Careful placement of the sensor is important to achieve good results.



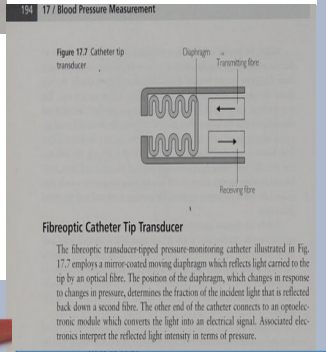

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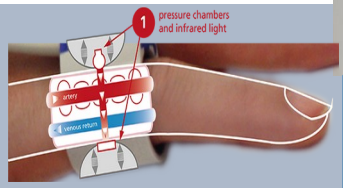
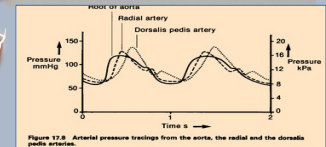
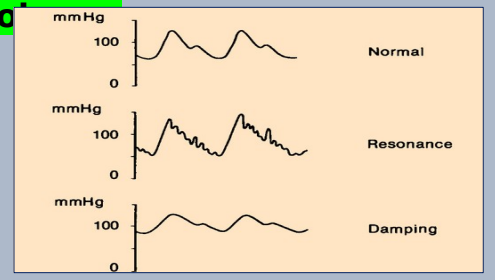
Figure 17.7 Catheter tip transducer
Diaphragm
Transmitting fibre
Receiving fibre
Fibreoptic Catheter Tip Transducer
The fibreoptic transducer-tipped pressure-monitoring catheter illustrated in Fig. 17.7 employs a mirror-coated moving diaphragm which reflects light carried to the tip by an optical fibre. The position of the diaphragm, which changes in response to changes in pressure, determines the fraction of the incident light that is reflected back down a second fibre. The other end of the catheter connects to an optoelectronic module which converts the light into an electrical signal. Associated electronics interpret the reflected light intensity in terms of pressure.





wave which is superimposed on the blood pressure waveform, giving distortion from resonance as shown on the Fig.
This problem can be avoided >>resonant frequency is outside the range of frequencies present in the blood pressure waveform. The resonant frequency of the combination of catheter and transducer can be raised >>using a shorter, wider or stiffer catheter, so the problem is generally worse when a long catheter is used. If there is any restriction to the transmission of the blood pressure from the artery to the transducer diaphragm>>pressure waveform will be damped or smoothed out so that sharp changes are not displayed (Fig.). Damping of this sort can be produced by air bubbles in the catheter or in the transducer chamber which absorb the pressure change in the saline column. It is also caused by clot formation in the cannula which restricts the movement of the saline co



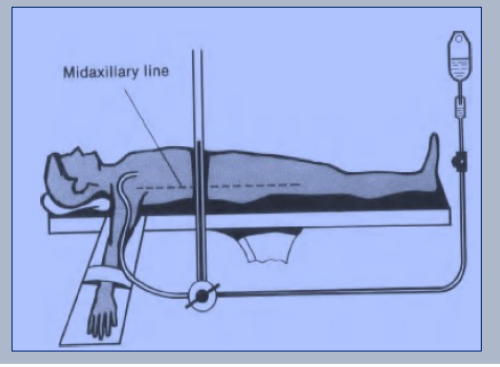
COMPARISON OF INVASIVE AND NON-INVASIVE TECHNIQUES:

The main advantage of the direct invasive technique of arterial pressure measurement is its potential accuracy, can also give reliable pressure readings even in the most hypotensive or shocked patient,(indirect techniques usually fail) .The invasive method gives a continuous record of the pressure in contrast to the intermittent record(non-invasive systems). And more accurate in patients with an irregular or fluctuating pulse rate. Disadvantages: 1-

CENTRAL VENOUS

mage. 2- more costly. 3- needs technical skill.

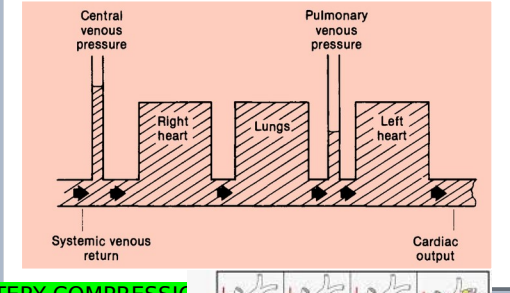
Distended Jugular veins in the absence of thoracic inlet obstruction indicate a raised venous pressure. To measure central venous pressure >>catheter reaches the superior vena cava. Attached to this catheter are a saline drip, T-piece and a manometer. Risks include neumothorax, haemothorax or hydrothorax and of infection. The zero of the scale is set to the level of the m**idaxillary line, this being taken as representative of the level of the right atrium. The saline drip should be turned off when readings are made and slight movements of the saline level with respiration indicate correct positioning of the catheter. Readings >>cmH2O>>conversion to SI units is simple as 1 cmH2O is about 100 Pa,**



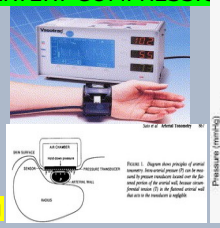
VENOUS PRESSURE AND CARDIAC

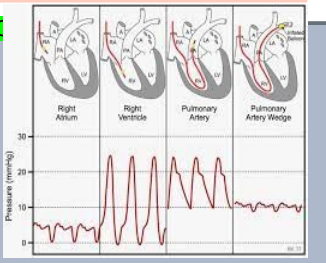
>>continuous recording waveform.

The filling of the heart >>Adequate venous pressure. If venous pressure rises, the normal heart fills to a greater extent and automatically increases its output even in the absence of autonomic innervation>>starling's law of the heart. Blood loss>> venous pressure falls >>a guide to transfusion. Both the right heart and pulmonary blood vessels are interposed between the central venous pressure recording point and he left heart. Consequently, in a patient with left heart disease excessive intravenous transfusion can give pulmonary oedema before the warning sign of a high central venous pressure is seen. On the other hand, in a patient with lung disease a high central venous pressure may be caused by failure of the right heart>> both left atrial and central venous pressures should therefore be monitored.
Measurement of pulmonary wedge pressure gives an indication of left atrial pressure. The pulmonary wedge pressure >>catheter through the right heart and pulmonary artery until it wedges into a small branch of the pulmonary artery >>pressure in the pulmonary capillaries. The special catheter used has a small balloon at its tip which can be inflated temporarily to facilitate its carriage into the pulmonary artery by the blood stream. It is also inflated during wedge pressure measurement. Continuous pressure recording helps to identify the position of the catheter and ensure that it is positioned in the pulmonary vessels before making the measurement.



RADIAL ARTERY COMPRESSIO





N.B A transducer having a sensing surface for sensing blood pressure within an underlying artery of a patient includes a transducer, a sidewall, a flexible diaphragm and a fluid coupling